Deep Convection across Gulf Coast Robs Appalachians of Moisture?

April 29-30, 2014 anticipated flooding and severe weather does not materialize

National Weather Service, Blacksburg VA
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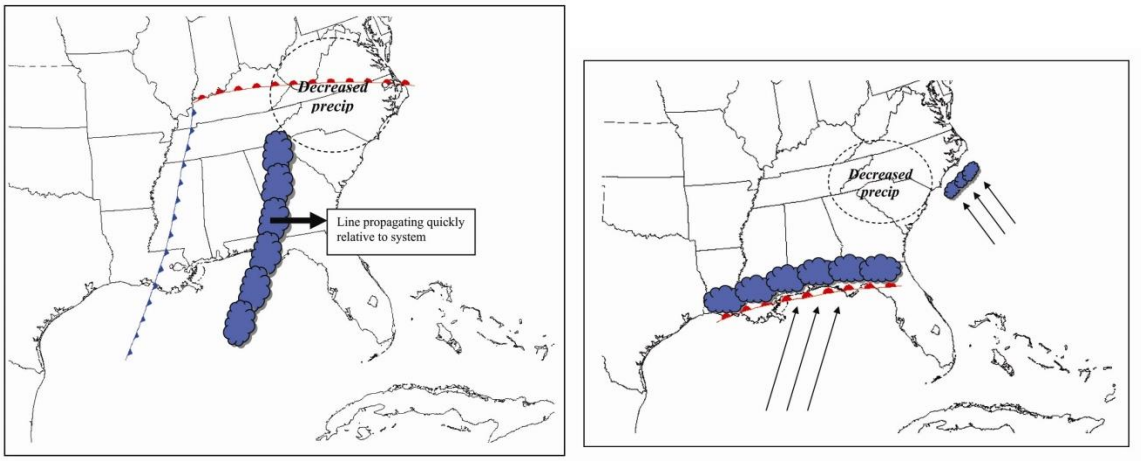
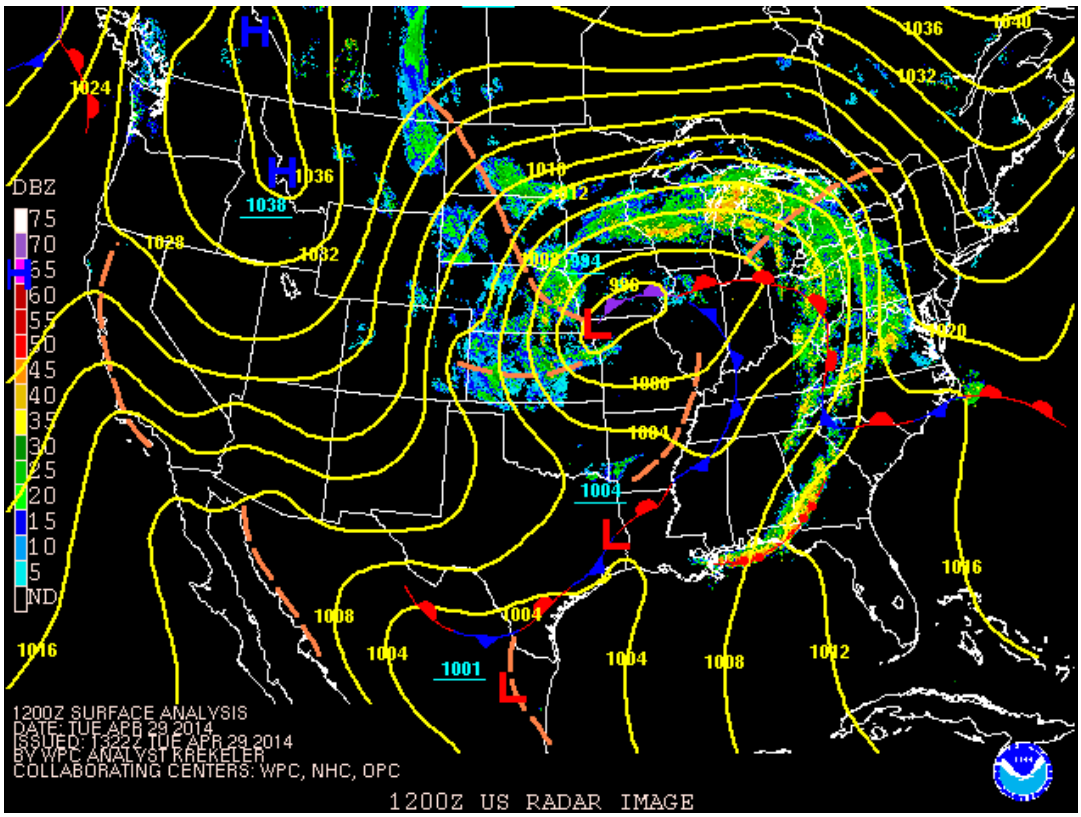
Forecasting convection, or thunderstorms, is one of the most difficult challenges in meteorology. Often we know what mode of convection is most likely (for example, isolated weak storms, isolated strong storms, organized lines, etc), and we can sometimes forecast the general area and timing, but there are other times when this is much harder. Computer forecast models also don't typically do very well with deep organized thunderstorm activity either.

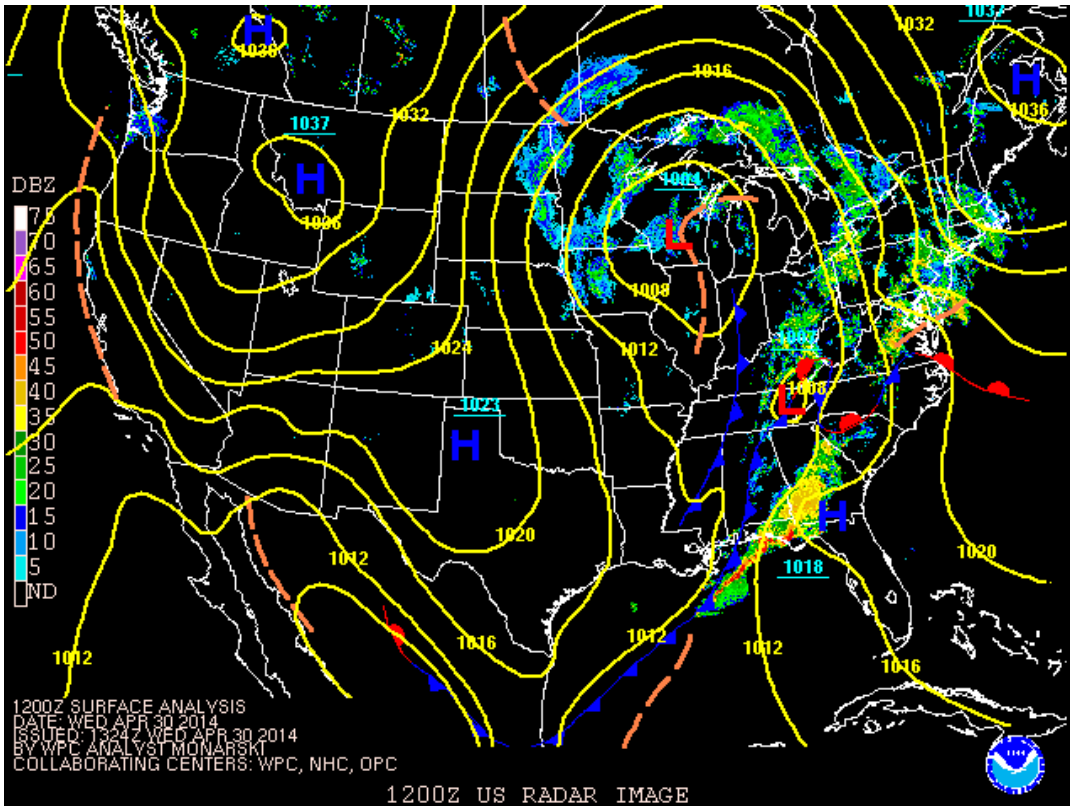
One of the situations that we already know computer models are challenged with is when a large area of organized convection develops along the Gulf Coast. When this does happen, studies at NC State University have confirmed what experienced forecasters have often noticed, that we can end up with less precipitation in this region of the Appalachians and Mid-Atlantic than originally forecast. An especially large area of thunderstorm along the Gulf Coast can effectively block the transportation of moisture from the Gulf of Mexico when there is southerly flow from that region. Much appears to depend on the orientation of the thunderstorm complex and the upper level flow in that region, but in the event that occurred earlier this week, we believe that greater-than-expected thunderstorm activity in the Gulf Coast region (mostly in terms of areal coverage) was a significant reason why this region experienced less precipitation (and thus very little flash flooding or river flooding) than expected.

The conceptual diagrams below depict two different processes in which widespread convection near the Gulf Coast can sometimes reduce the precipitation (to the north in these cases). These come from a study conducted by NC State University in collaboration with area NWS offices (Mahoney and Lackmann, 2007). This relationship is very complex however, as there are other scenarios with convection in the Gulf Region that can potentially lead to enhanced precipitation over the Appalachians and Mid-Atlantic region. The pattern this week appears to have been a hybrid of many of these scenarios.



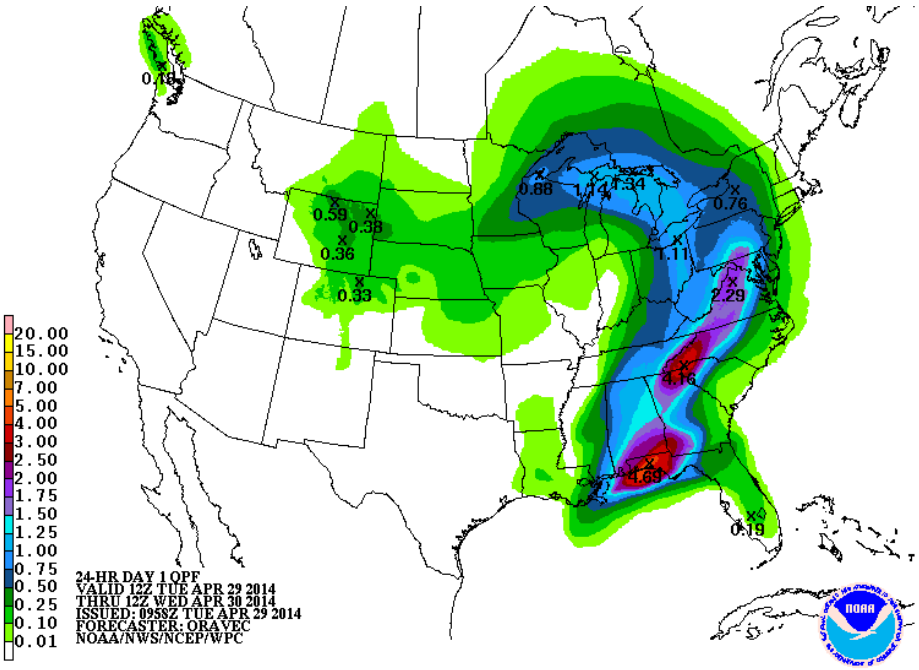
The two maps below with a radar mosaic and surface analysis overlaid are from Tuesday morning (April 29) and then Wednesday morning (April 30) respectively, and show that there were two separate periods when a large and deep complex of thunderstorms stretched along much of the Gulf Coast region, with relatively weak or no activity over western NC and southwestern VA.

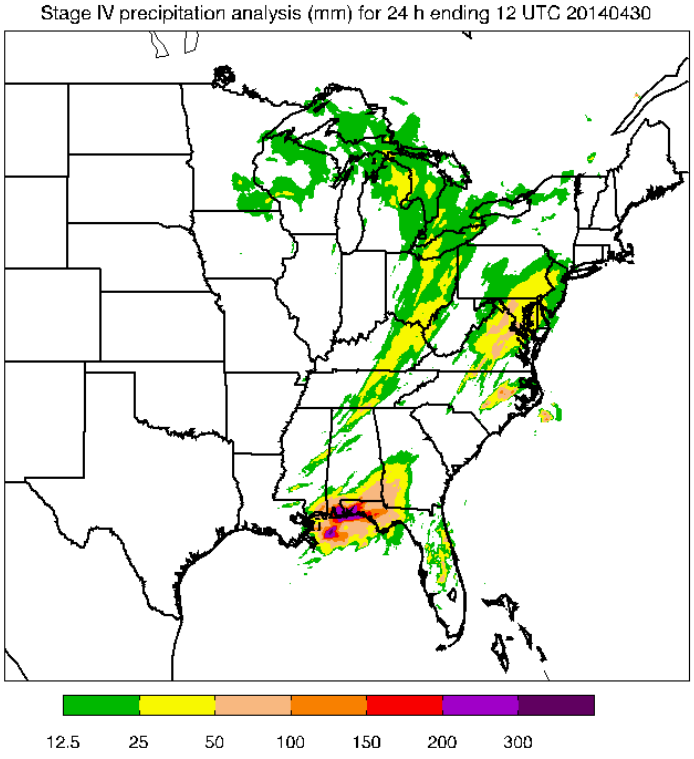




Most computer model forecasts of rainfall 12 to 24 hours or more in advance of this time period, as well as forecasters, *underestimated* the amounts from convection along the Gulf Coast, and in part because of this, *overestimated* the expected rainfall over the southern Appalachians. The image below shows a U.S.-wide rainfall forecast map for the 24-hour period Tuesday and Tuesday night, which combines many computer forecasts along with input from meteorologists, and shows while there was a maximum in rainfall expected along the Gulf (a large area of 2-4 inches), there was also heavy precipitation expected farther north along the Appalachians (also 2-4 inches).

In reality (shown in the very last image), the waves of organized storms along the Gulf were much more intense and slow-moving than expected, which resulted in an area of 4-8 inches of rain with even locally higher amounts (the units in this image are in millimeters and only amounts of a half inch or greater are shown). At the same time, very little rain fell across the southern Appalachians (although there were significant amounts farther north across northern VA and MD). As a result, the expected threat of flash flooding and river flooding, as well as severe weather, was not realized (other than some minor flooding in our Piedmont). More significant severe weather, including tornadoes, as well as some flash flooding did occur in eastern NC late Tuesday.


0.18
0.59
0.38
0.36
0.33
0.88
1.14
1.34
0.76
1.11
2.29
4.16
4.69
0.19
20.00
15.00
10.00
7.00
5.00
4.00
3.00
2.50
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.10
0.01
24-HR DAY 1 QPF
VALID 12Z TUE APR 29 2014
THRU 12Z WED APR 30 2014
ISSUED: 0958Z TUE APR 29 2014
FORECASTER: ORAVEC
NOAA/NWS/NCEP/WPC
NOAA


Stage IV precipitation analysis (mm) for 24 h ending 12 UTC 20140430
12.5
25
50
100
150
200
300

In summary, this was not a well-forecast event by models or humans, especially in terms of the precipitation, and shows that when it comes to forecasting large areas of thunderstorms and associated rainfall, there is much room for improvement in the models as well as forecaster techniques used to improve upon the automated model output. Studies like the NC State collaborative effort mentioned here help toward improving operational techniques and improving the models for these kinds of scenarios, yet clearly much additional work is needed before forecasters can confidently make significant adjustments to a strong consensus in the operational guidance. This event will certainly be studied in greater detail by forecasters and researchers alike, working together to develop better techniques and improve models.

Reference:

Mahoney, K.M. and G.M. Lackmann, 2007: The Effect of Upstream Convection on Downstream Precipitation. *Wea. Forecasting.,* **22,** 255-277.